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Original Research

Distribution of nosocomial infections caused by *Klebsiella pneumoniae* ESBL strain

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Abstract

Objectives: Hospital outbreaks of multidrug-resistant *Klebsiella species*, especially those in neonatal wards, are often caused by new types of strains, the so-called extended-spectrum-β-lactamase (ESBL) producers.

Methods: The aim of this study was to determine the distribution of nosocomial infections caused by *Klebsiella pneumoniae* ESBL strain by location and kind of infections on the University Clinical Center Tuzla during a period of one year. A prospective study was implemented for all patients who developed hospital infections caused by *Klebsiella pneumoniae* ESBL strain during the period from the 1st of January to 31st of December 2010. Determination of nosocomial infections was performed using standardized Centers for Disease Control (CDC) criteria. Mandatory registration of hospital infections was done via a written application form which was used for surveillance.

Results: Hospital infections caused by *Klebsiella pneumoniae* ESBL strain were reported 141 times, during the year 2010. Most common hospital infections were urinary tract infections 52 times (36.9%), followed by respiratory tract infections 43 times (30.5%), infections of the gastrointestinal system 20 times (14.2%), infections of surgical sites 12 times (8.5%), 10 times (7.1%) the bloodstream infections and other infections 4 times (2.8%). Nosocomial infection was mostly reported on the Clinic of Anesthesiology and Reanimation 37 times (26.2%) and the Clinic for Children's Diseases 33 times (23.4%). Regarding age, 41 (29.1%) of nosocomial infections were detected in patients below the age of one year and 35 (24.8%) in patients above the age of 65 years.

Conclusion: It is necessary to continue to monitor occurrence and the distribution of nosocomial infections caused by *Klebsiella pneumoniase* ESBL strain in order to find solutions to their reduction and prevention.

INTRODUCTION

Klebsiella pneumoniae is among the most common gram-negative bacteria encountered by physicians worldwide. It is a common hospital-acquired pathogen, causing urinary tract infections, nosocomial pneumonia, and intraabdominal infections. *Klebsiella pneumoniae* is also a potential community-acquired pathogen [1]. *Klebsiellae* are ubiquitous in nature. In humans, they may colonize the skin, pharynx, or gastrointestinal tract. They may also colonize sterile wounds and urine. *Klebsiellae* may be regarded as normal flora in many parts of the colon and intestinal tract and in the biliary tract. Oropharyngeal carriage has been associated with endotracheal intubation, impaired host defenses, and antimicrobial use [2]. Important manifestations of *Klebsiellae* infection in the hospital setting include UTI, pneumonia, bacteremia, wound infection, cholecystitis, and catheter-associated bacteriuria. Other nosocomial infections in which *Klebsiellae* may also be implicated include cholangitis, meningitis, endocarditis, and bacterial endophthalmitis. Nosocomial infections may affect adults or children, and they occur more frequently in premature infants,

patients in neonatal intensive care units, and hospitalized individuals who are immunocompromised [2]. Bacteria belonging to the genus *Klebsiella* frequently cause human nosocomial infections. In particular, the medically most important *Klebsiella species*, *Klebsiella pneumoniae*, accounts for a significant proportion of hospital-acquired urinary tract infections, pneumonia, septicemias, and soft tissue infections. The principal pathogenic reservoirs for transmission of *Klebsiella* are the gastrointestinal tract and the hands of hospital personnel. Because of their ability to spread rapidly in the hospital environment, these bacteria tend to cause nosocomial outbreaks. Hospital outbreaks of multidrug-resistant *Klebsiella species*, especially those in neonatal wards, are often caused by new types of strains, the so-called extended-spectrum-β-lactamase (ESBL) producers. The incidence of ESBL-producing strains among clinical *Klebsiella* isolates has been steadily increasing over the past years. The resulting limitations on the therapeutic options demand new measures for the management of *Klebsiella* hospital infections. While the different typing methods are useful epidemiological tools for infection control, recent findings about *Klebsiella* virulence factors have provided new insights into the pathogenic strategies of these bacteria [3]. In recent years ESBL- *Klebsiella pneumoniae* isolates have produced significant outbreaks in hospitals worldwide [4]. Hospital outbreaks of multidrug-resistant *Klebsiella species*, especially those in neonatal wards, are often caused by new types of strains, the so-called ESBL producers [3]. *Klebsiella pneumoniae*, an important cause of nosocomial infections, is among those organisms that produce ESBLs [5]. For the purposes of the National Healthcare Safety Network (NHSN) surveillance in the acute care setting, the Centers for Disease Control (CDC) defines an hospital-acquired infection (HAI) as a localized or systemic condition resulting from an adverse reaction to the presence of an infectious agent(s) or its toxin(s). There must be no evidence that the infection was present or incubating at the time of admission to the acute care setting [6]. The aim of this study was to determine the distribution of nosocomial infections due to *Klebsiella pneumoniae* ESBL strain on the University Clinical Center Tuzla over a period of one year.

MATERIAL AND METHODS

A prospective study was implemented for all patients who developed hospital infections caused by *Klebsiella pneumoniae* ESBL strain during the period from 1st of January to 31st of December 2010. All laboratory testing was performed at the Institute for Microbiology of the University Clinical Center Tuzla. Diagnosis of nosocomial infection was made using the CDC criteria. Nosocomial infection was defined as an infection acquired more than 48 hours after being admitted to a hospital. Mandatory registration of hospital infections was done via a written application form which was used for surveillance. In our study we observed ethical principles outlined in the World Medical Association Declaration of Helsinki.

RESULTS

Hospital infections caused by *Klebsiella pneumoniae* ESBL strain were reported 141 times at the Clinical Center Tuzla during the period from the1st of January to 31st of December 2010. Thereof the most common hospital infections were urinary tract infections 52 times (36.9%), followed by respiratory tract infections 43 times (30.5%), infections of the gastrointestinal system 20 times (14.2%), infections of surgical sites 12 times (8.5%), the bloodstream infections 10 times (7.1%) and other infections 4 times (2.8%) (Figure 1.). Among other infections there were infections of skin and central nervous system, gynecological and eye infections.

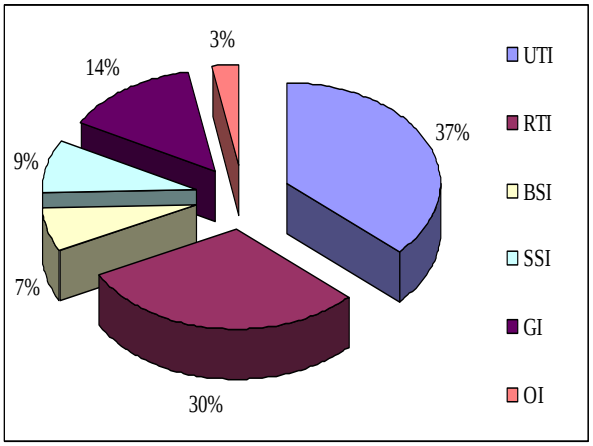

Figure 1. Nosocomial infections caused by *Klebsiella pneumoniae* ESBL strain by type of infection

Nosocomial infections were mostly reported in the Clinic of Anesthesiology and Reanimation 37 times (26.2%) and the Clinic for Children's Diseases 33 times (23.4%) (Table 1). At the Clinic for Children's Diseases 14 (42.4%) infections were recorded in the unit for newborns and 7 (21.2%) in the intensive care unit while the other infections occurred in the wards.

From a total of 141 patients with reported infections 90 (65%) were males and 51 (35%) females. Regarding age, 41 (29.1%) of nosocomial infections were detected in patients below the age of one year and 35 (24.8%) in patients above the age of 65 years. In patients below

one year of age, nosocomial infections caused by *Klebsiella pneumoniae* ESBL were reported mostly in the neonatal unit of the Clinic for Gynecology and Obstetrics and the Clinic for Children's Diseases. Among them, in the Department of Obstetrics and Gynecology there were 10 infections of gastrointestinal system, 2 bloodstream infections, 2 urinary tract infections and 1 respiratory infection. At the Clinic of Children's Diseases, there were 7 urinary tract infections, 6 infections of the gastrointestinal tract, 5 respiratory tract infections, 4 bloodstream infections, 2 eye infections and 1 infection of the central nervous system (CNS).

Ninety-three (65.9%) infections caused by *Klebsiella pneumoniae* ESBL strain occurred in non intensive care units (NICU), 48 (34.1%) in intensive care units (ICU). Respiratory tract infections were reported more frequently in the intensive care unit than in the wards (60.3% in ICUs versus 15.1% in non ICU wards). However, infections of the urinary tract were reported more frequently in the wards than in intensive care units (44.1% in non ICU wards versus 22.9% in ICUs). Gastrointestinal infections were reported more frequently in the non ICU wards than in intensive care units (ICU) (20.4% in non ICU wards versus 2.1% in ICU wards) (Table 2).

Table 1. Distribution of cases of nosocomial infections by place and type of infection

Clinic/Department	Nosocomial infections						
	UTI No (%) N=52	RTI No (%) N=43	BSI No (%) N=10	SSI No (%) N=12	GIT No (%) N=20	Others No (%) N=4	Total No (%) N=141
Clinic for Orthopedics and Traumatology	3 (5.8)	0 (0.0)	0 (0.0)	1 (8.3)	0 (0.0)	0 (0.0)	4 (2.8)
Clinic for Cardiovascular Diseases	0 (0.0)	4 (9.3)	0 (0.0)	1 (8.3)	0 (0.0)	0 (0.0)	5 (3.5)
Clinic for Gynecology and Obstetrics	3 (5.8)	1 (2.3)	2 (20.0)	2 (16.7)	10 (50.0)	1 (25.0)	19 (13.5)
Clinic of General and Abdominal Surgery	8 (15.4)	3 (7.0)	0 (0.0)	2 (16.7)	2 (10.0)	0 (0.0)	15 (10.6)
Internal Medicine Clinic	3 (5.8)	0 (0.0)	0 (0.0)	1 (8.3)	0 (0.0)	0 (0.0)	4 (2.8)
Clinic for Infectious Diseases	1 (1.9)	0 (0.0)	1 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.4)
Clinic for Lung Diseases	3 (5.8)	3 (7.0)	0 (0.0)	1 (8.3)	0 (0.0)	0 (0.0)	7 (5.0)
Clinic for Neurology	1 (1.9)	1 (2.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.4)
Clinic of Anesthesiology and Reanimation	9 (17.3)	22 (51.2)	3 (30.0)	3 (25.0)	0 (0.0)	0 (0.0)	37 (26.2)
Clinic for Physical Medicine and Rehabilitation	9 (17.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	9 (6.4)
Clinic for Children's Diseases	10 (19.2)	8 (18.6)	4 (40.0)	0 (0.0)	8 (40.0)	3 (75.0)	33 (23.4)
Clinic for Otorhinolaryngology	0 (0.0)	1 (2.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)
Department of Palliative Care	2 (3.8)	0 (0.0)	0 (0.0)	1 (8.3)	0 (0.0)	0 (0.0)	3 (2.1)
Total	52 (36.9)	43 (30.5)	10 (7.1)	12 (8.5)	20 (14.2)	4 (2.8)	141 (100)

UTI - urinary tract infection, RTI - respiratory tract infection, BSI - blood stream infections, SSI - surgical site infection, GIT- gastrointestinal tract infection, OI - others infection

Table 2. Nosocomial infections in ICU and non ICU

Nosocomial infection	No. (%) of isolates			
	ICU			Non ICU
	Clinic of Anesthesiology and Reanimation No (%) N=(37)[a]	Other Clinics No (%) N=(11)	Total No (%) N=(48)	No (%) N=(93)
BSI (blood stream infections)	3 (8.1)	0 (0.0)	3 (6.3)	7 (7.5)
SSI (surgical site infection)	3 (8.1)	0 (0.0)	3 (6.3)	9 (9.7)
RTI (respiratory tract infection)	22 (59.5)	7 (63.6)	29 (60.3)	14 (15.1)
UTI (urinary tract infection)	9 (24.3)	2 (18.2)	11 (22.9)	41 (44.1)
GIT (gastrointestinal system infection)	0 (0.0)	1 (9.1)	1 (2.1)	19 (20.4)
Others (others infection)	0 (0.0)	1 (9.1)	1 (2.1)	3 (3.2)
Total	37 (77.1)	11 (22.9)	48 (34.1)	93 (65.9)

[a)] N indicates total number of patients

ICU - Intensive care unit, NICU – Non intensive care unit

DISCUSSION

Many studies [7,9,10,11,12,13,14,15,16] have shown that *Klebsiella pneumoniae* ESBL is important nosocomial pathogen which causes bloodstream infections, urinary tract infections, respiratory tract infections, surgical site infections, skin infections and other infections in hospitals around the world. Saonuama et al. [7] have reported that of the 381 episodes of infections caused by *Klebsiella pneumoniae*, there were 226 (59.31 %) ESBL-producing strains. The infected sites caused by ESBL-producing strains were the respiratory tract (42.53%), urinary tract (33.71%), surgical wounds (12.90%), skin and soft tissue (5.66%), and blood-stream (5.20%). Similar results were found in our study. One study [8] reported that of the 33 patients with ESBL-producing *Escherichia coli* (*E. coli*) or *Klebsiella pneumoniae* infection, 25 (75.8%) of them had infections due to *Klebsiella pneumoniae* and 8 (24.2%) had infections due to *E. coli.* The sites of infection were as follows: urinary, in 17 patients (51.5%); wound, in 5 (15.2%); central venous catheter, in 4 (12.1%); blood, in 3 (9.1%); respiratory, in 3 (9.1%); and abdominal, in 1 (3.0%).

Extended-spectrum β-lactamase was present among *Klebsiella pneumoniae* isolates, was widely disseminated in different wards and remained persistent as a result of an outbreak involving the dissemination of both the multi-resistance plasmids harboring the *bla* gene and the isolates themselves [5]. Our results also showed that the nosocomial infections caused by *Klebsiella pneumoniae* ESBL strain were widely disseminated in different wards.

In a tertiary care hospital in Tehran, *Klebsiella pneumoniae* isolates were frequently isolated from patients at the extreme ages (i.e., less than two years (35.6%) and 61+ years (30.7%). In relation to gender there was a slightly higher representation of men [9]. In a similar study conducted in Spain [4] among those who had infections caused by *Klebsiella pneumoniae* with ESBL there were 58.7% men and 43.2% women. Similarly, in our hospital, nosocomial Klebsiella pneumoniae ESBL infections were more common in men than women. More than half of hospital infections due to *Klebsiella pneumoniae* ESBL were present in the youngest and the oldest patients. In the other study done in Iran [10] it has been reported that thirty two percent of isolates had ESBL phenotype belonging to 21 (52.5%) male and 19 (47.5%) female with mean age of 39.27±19.2.

Peña et al. [4]. have reported significant differences in the source of *Klebsiella pneumoniae* ESBL isolates between the ICUs and the non-ICU wards. In the ICUs isolates were more frequently detected in blood samples (40% in ICUs versus 16% in non-ICU wards) and respiratory tract samples (26% in ICUs versus 3% in non-ICU wards), whereas in the non-ICU wards isolates were more frequently detected in urine samples (23% in ICUs versus 55% in non-ICU wards) and surgical wound samples (18% in ICUs versus 34% in non-ICU wards). A total of 145 patients were affected. Of these, 107 were ICU patients (72%), and the

remaining 38 patients (28%) acquired the infection or colonization in a non-ICU setting [4]. In the present study, we found that infections more frequently occurred in wards versus ICUs and we observed significant differences in the source of *Klebsiella pneumoniae* ESBL isolates between the ICUs and the non-ICU wards. Our study has shown that respiratory infections were reported more frequently in the intensive care unit than in the non-ICU wards. Urinary tract infections were reported more frequently in the non ICU wards than in intensive care units. The results are very similar to those reported by Peña et al. ESBL-producing *Klebsiella pneumoniae* BSIs were significantly more common in the ICU (19 of 34 cases; 56%) than in surgical wards (56% versus 35%; 12 of 34 cases), or medical wards (56% versus 21%; 17 of 79 cases) [11]. We had a much smaller number of bloodstream infections in comparison to other types of infection.

ESBLs have become widespread throughout the world [12]. Silva et al. suggest that the use of antibiotics or underlying disease that increase chance of antibiotic are the main risk factors for *Klebsiella pneumoniae* ESBL infections. Thus, it is necessary to continue to monitor occurrence and the distribution of these infections and find solutions to their reduction and prevention. Conducting a persistent surveillance, it could be possible to overview the global situation of nosocomial infections in hospitals, with epidemiological surveillance representing an essential tool for the program for prevention and control of nosocomial infections.

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